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On the Issue of Efficiency in the Transportation of Oil Products by Main Pipelines

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ABSTRACT

Pipeline transportation of oil products can rightfully be called the most unusual form of transportation. Today, Uzbekistan is starting to supply oil to the world. It provides an opportunity to deliver oil, diesel fuel, gasoline in any direction and in practically unlimited quantities. Transportation of oil products through pipelines allows for the continuous pumping of various types of oil and gas. Its work does not depend on climate, geographical location, year or time of day - that is, it is carried out continuously and systematically. A pipeline route is always shorter than a road or rail route, so transportation along it is faster. In addition, pipeline transportation of petroleum products has the best technical and economic indicators compared to other modes of transportation. Its use helps to reduce the loss of oil products, reduce energy consumption and reduce the need for maintenance personnel. Disadvantages include the lack of flexibility in the logistics scheme of transport: after the pipeline is laid, it will not be possible to change or adjust the route of transport.

KEYWORDS: *Oil, turbulent, money view, pump, power consumption, electric power, pipeline, pumping station, pump flow consumption, pump efficiency, pump unit*

Introduction

The efficiency of transportation of oil products through pipelines is determined by the pumping mode obtained as a result of combining the characteristics of the pump and the pipeline. The article proposes analytical relationships that provide a relationship between the unit costs of electricity and the efficiency of the pump unit, and also allows to evaluate the effectiveness of the anti-turbulent additive used in monetary terms.

STATEMENT OF THE ISSUE

The efficiency of transportation of oil products through pipelines is determined by the pumping mode obtained as a result of combining the characteristics of the pump and the pipeline. These properties change when the properties of the pumped medium change, when anti-turbulent and depressant additives are added, and when any structural changes are made to the pipeline or pump. The general characteristics of the pump and the pipeline can be changed by connecting additional pumping stations or increasing the engine speed. An example of a combined pump and pipeline characteristic is shown in Figure 1.

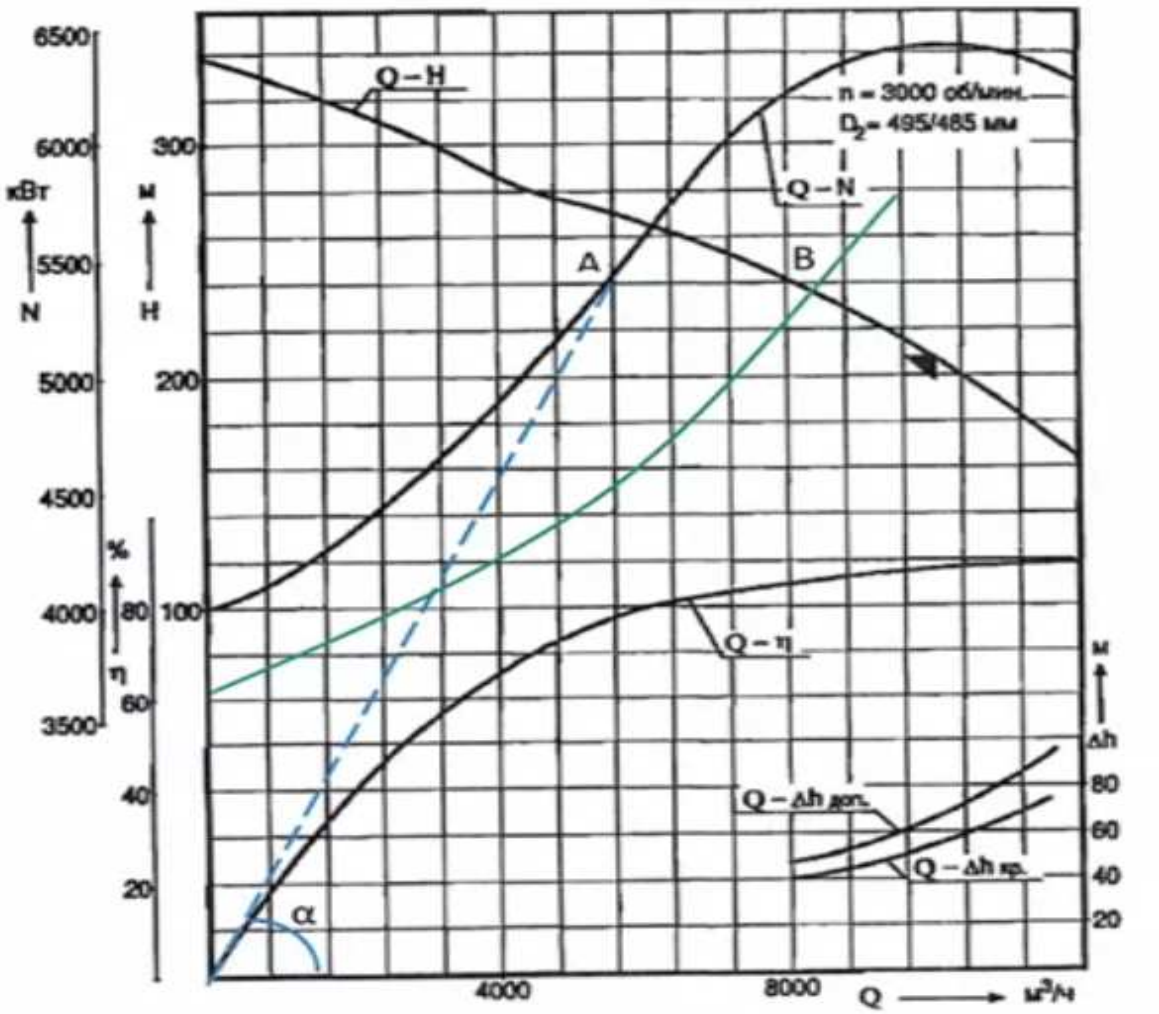

Figure 1 - Combined characteristics of the pump and pipeline

The characteristic of the pipeline intersected with the characteristic of the Q-H pump determines the actual mode, power consumption and efficiency. The characteristic of the pipeline can be adjusted to lower flows along the characteristic of the pump, and to higher flows - by reducing the resistance of the pipeline. The main parameter that determines the efficiency of the pump is the efficiency in the area of the given flows. However, in changing pumping conditions: changing the characteristics of the pumped medium, changing the sequence and parameters of the connected pumps, it is difficult to quickly determine the efficiency. What is needed is a parameter that determines not only the efficiency of the pump, but also the efficiency of the pump, which is easily measured and connects the pipeline, the pump and the electricity.

It can be seen from the analysis of the literature that there are various objective functions for optimizing the operating modes of MN and MNPP - the volume of electric power, the power of electric power, the total cost of electric power for the pump, the efficiency of the pump units. , PS efficiency, etc. [1-13].

SOLUTION METHOD

In many works, unit costs of electricity are used to calculate the efficiency of driving oil products [14, 15].

Such a parameter can be easily measured, has the necessary information content and takes into account the characteristics of both the pump and the pipeline [16, 17].

Specific costs of the pump unit can be defined as the ratio of power consumption to pump flow.

$$N_{yd} = \frac{N_{nomp}}{Q} \qquad (1)$$

Here:

N_{yd} - comparative costs of electricity, kVt/m3;

N_{nomp} - nasosning quvvat sarfi, kVt;

Q - pump flow rate, m3/soat.

Table-1 shows the specific energy consumption of the K290/30 -290, K290/30 pump in the optimal supply mode (0.8-1.2 Qopt) according to the passport data. Similar connections are presented in [16, 17, 18, 19, 20]. These are the minimum cost values at

which the pump operates in water. As the viscosity of the pumped liquid increases, as well as the wear of the pump elements (end and slot seals), unit costs increase.

As a result of the wear of the slotted seals and other elements of the pump, the efficiency decreases and the specific energy consumption increases, and the operating unit can reach a threshold value where it can become ineffective. Thus, experimental studies of NM-type pumps show that the efficiency decreases to 5% when the gap increases by 0.5 mm.

Table 1 - Special minimum energy consumption of pumps K290/30, K90/55 according to passport data.

"SUVMASH" JSC is produced "K", "D" and "ESV" type pumps

Pump brand			Water Consumpton m3/soat (l/sek)	Napor m	Number of rotations ay/daq	Electric motor power kVt	Tension, V
Nowadays	Old name						
K200-125-330	K290/30	8K12	290 (80,6)	30	1450	37 (45)	380
	K290/30a	8K12a	250(69,4)	24	1450	30	380
K200-150-268	K290/18	8K18	290(80,6)	18	1450	22 (30)	380
	K290/18a	8K18a	260 (72,2)	15,5	1450	18,5	380
K100-65-250	K90/85	4K6	100 (27,8)	80	2900	45	380
	K90/85	4K6	90 (25,0)	85	2900	45	380
K100-65-250a	K90/85a	4K6a	90 (25,0)	67	2900	37	380
	K90/85a	4K6a	85 (23,6)	76	2900	37	380
K100-65-200	K90/55	4K8	100 (27,8)	50	2900	30	380
K100-65-200a	K90/40	4K8a	90 (25,0)	40	2900	22	380
Д6300-27	32Д19		6300(1750)	27	730	630	6000
Д6300-80	24НДс		6300(1750)	80	730	2000	6000
Д4000-95	22НДс		4000(1111)	95	980	1000	6000
Д3200-75	20НДс		3200(888)	75	980	1000	6000
Д3200-33	20НДн		3200(888)	33	980	4000	6000
Д2500-62	18НДс		2500(694)	62	980	630	6000
ЭЦВ6-10-80	-		10(2,8)	80	2870	4,5	380
ЭЦВ8-16-160М	-		16 (4,4)	160	2920	11	380
ЭЦВ8-16-80М	-		16 (4,4)	80	2920	11	380
ЭЦВ8-25-100М	-		25 (7,0)	100	2850	11	380
ЭЦВ8-40-90М	-		40 (11,1)	90	2850	16	380
ЭЦВ8-40-60М	-		40 (11,1)	60	2920	11	380

0,8-1,2 Q_{opt} the analysis of the relative energy consumption depending on the pump mode in the region shows that the characteristics for each HM pump increase the efficiency of the pump with an increase in flow (Table 1).

If the power consumption is written in terms of pump efficiency, we get

$$N_{yo} = \frac{QH\rho g}{Q\eta_{nas}} = \frac{P}{\eta_{nas}} \qquad (2)$$

Here:

η_{nas}- pump efficiency;

ρ- the density of the pumped medium;

P - differential pressure across the pump.

Let's see how the specific costs of electricity change depending on the pumping mode and the number of pumping stations. Figure 2 shows the dependence of head H and power N on the supply of three series-connected centrifugal pumps. These are H_1, H_2, H_3 va N_1, N_2, N_3 curves, also, Q_{ta}, Q_{tb}, Q_{ts} possible characteristics of pipes. If we draw the beam from the origin to any point of the power consumption characteristic (for example, point a in Figures 1 and 2), then we see that the relative power consumption is the tangent of the slope. All points of light correspond to the same energy consumption. Analysis of the characteristics of field and main centrifugal pumps shows that the specific energy consumption of the pumps decreases as the flow rate Q increases. This is an important point in favor of the use of depressants and anti-turbulent additives and allows a simple and accurate analysis of pump efficiency.

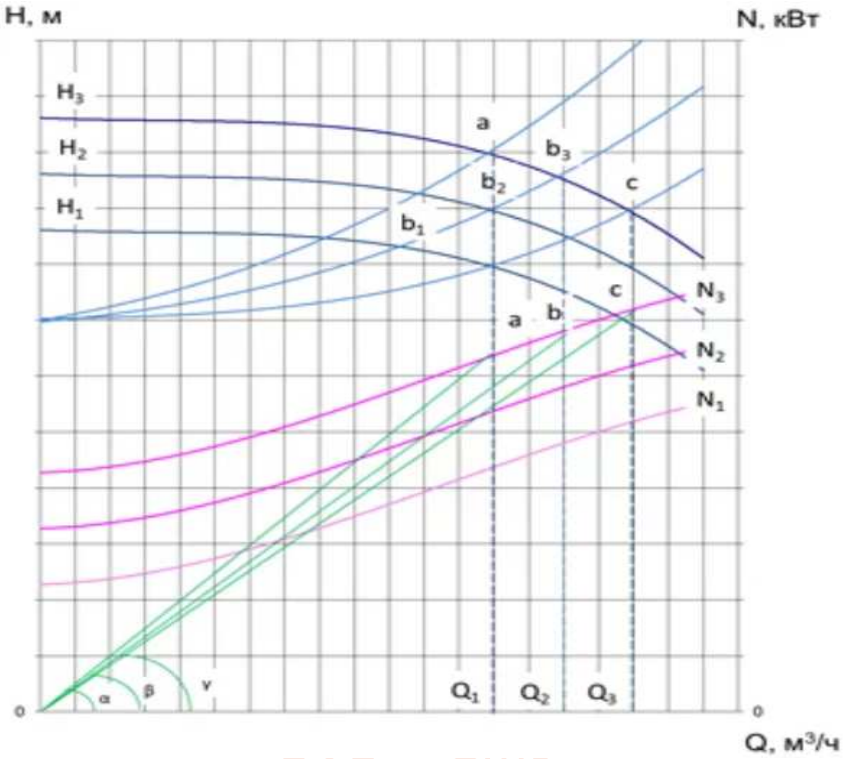

Figure 2 - Dependence of pressure H and power N on the supply of three series-connected centrifugal pumps.

If it is necessary to increase the flow rate from Q_1 to Q_3 according to the H3 characteristic, this can be done by installing, adding or adding a loop or anti-turbulent additive to the oil. At the same time, our efforts will be rewarded if the costs of switching to the new mode are paid for by lower specific power consumption and increased pump capacity. As a result, we can estimate how much it will cost us to increase the flow through the pipeline.

Let's consider the case when the characteristic of the pump with the connection of the next station moves along the unchanged characteristic of the pipeline, for example, from point b1 to points b2 and b3 (Fig. 2). As can be seen from Figure 2, the unit cost of pumps increases with the connection of each pumping station. Costs also increase with the number of revolutions. Costs are reduced when cutting the propeller. These conclusions also follow from formula (2).

Neglecting the characteristics of the terrain, we modify the formula (2) using the Darcy-Weisbach equation and obtain specific energy costs in the technological section.

$$N_{yд} = \frac{\lambda L v^2}{2D\eta}\rho \qquad (3)$$

The resulting formula allows determining the relative power consumption $N_{уд}$ depending on the design parameters of the pipeline: L - length and D - diameter, as well as technological parameters: v - fluid velocity in the pipeline, λ - coefficient of hydraulic resistance of the pipeline, ρ- density of the pumped medium and η - Efficiency of the pumping device. Thus, the specific energy costs are determined by the hydraulic losses in the pipeline and the efficiency of the pump unit.

Knowing the relationship between the value of the unit cost of electricity and the activity carried out by the pipeline or pump, the economic efficiency of this activity can be determined.

As an example, consider using anti-turbulence additives to increase pumping capacity and possibly reduce energy costs.

If the design parameters of the pipeline have not changed and the efficiency of the additive is determined as follows, then formula (3) can be obtained.

$$N_f = N_0(1-\psi)\frac{Q_f^2}{Q_0^2}\frac{\eta_0}{\eta_{fq}} \qquad (4)$$

Q_f- the new pump volume obtained by applying the addn;

η_0 and η_{fq}- Q_0 va Q_f the efficiency of the pump unit at the flow rate, the same liquid without addition passes through the pump.

If we add such a concentration of additive to meet the planned goal of increasing Q_f, using formula (4), we find how much the specific energy costs change, and the action of adding the additive - we will find out the costs of activities, determine how effectively the supplement will be used in general.

When moving from the flow rate Q_0 to Q_f, unit costs decrease by $D_N = N_0 - N_f$, which in monetary terms is D_N Rel, where Rel is the price of electricity.

In this case, there will be a benefit from using the supplement

$$Э_{пр} = P_{эл}\Delta N t + \Delta T - \Delta З, \qquad (5)$$

Here:
Δ3- the costs of implementing the technological process of producing pumps with an addition;

t- validity period of the supplement;

ΔT- additional tariff revenues from increased pipeline capacity.

RESULTS AND SAMPLES

Similarly, formulas (3) and (4) allow to calculate the efficiency of the pipeline in transporting oil from OPS to OPS or from a tank farm to a tank farm in a technological section.

When changing the properties of the pumped medium, different values of λ and the efficiency of the pump unit are obtained. The values of λ are set when Newtonian and non-Newtonian fluids, mixtures of different oils or when condensate, depressant or anti-turbulent additives are added to the oil. Values of λ should be obtained from laboratory studies or well-known literature sources. The obtained theoretical correlations require approval in the conditions of industrial experiments.

CONCLUSIONS

1. The resulting relationships give the relationship between the specific costs of electricity and the efficiency of the pump unit.
2. Also, the relationships obtained allow evaluating the efficiency of the used anti-turbulent additive in monetary terms.

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